REPRODUCTIVE PERIODS IN BIRDS NEAR THE EQUATOR

BY

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Birds reproduce in most parts of the world during limited periods of the year. Only in the breeding season are the gonads, especially those of the male, enlarged and the individual is then physiologically in breeding condition. In all birds upon which experiments have been performed with artificial light, it has been found that longer days stimulate breeding and shorter days tend to stop breeding or to prevent the development of the gonads to full breeding capacity. Since the pioneer work of William Rowan in 1929, we have known that sparrows of various species could be stimulated to breeding condition by giving them longer days in experimental cages during northern winters and thus made ready for breeding even in December. This knowledge also has been used practically in northern latitudes to stimulate chickens to produce eggs for the markets during the winter.

In birds much experimental work on north temperate species since Rowan's time has been carried on by Burger in the eastern United States, by Wolfson at Chicago, by Farner at Washington State College, and by our group at the University of California in Berkeley. In general it has been shown that the pituitary gland is stimulated by long days, apparently through the eyes normally, and thence through the nerve pathways and centers of the mid-brain. The gonadotropic hormones of the pituitary are thus produced in greater amount and stimulate the seasonal development of the gonads. Also we know that this pituitary-gonad mechanism requires periods of rest. During these rest periods light will not stimulate it and we say that it is refractory. This need for rest and the tendency to regrow thereafter constitute an inherent rhythmic tendency. In almost all species this tendency is modified by environmental stimuli, such as light, so that the breeding activity comes only at a particular season or part of the calendar year.

The great need now is to learn more about the seasons of breeding near the equator, since only here is natural day length essentially equal throughout the year. This situation allows us to observe in some species their innate rhythmic tendency and in others to determine what factors other than light can stimulate the breeding at particular times of the year. This is why I came to Colombia in 1958 for field research.

When birds nest at the equator and are therefore not stimulated by changes in day length, some species might be expected to breed throughout the year. Those species that do this, however, still have cycles for the individual. No one individual can breed at all times, but because each individual is on a different cycle the species seems to be nesting all the year around.

Earlier in my former studies in Colombia in 1949 I worked in the upper Magdalena Valley a little north of Neiva. Here, there is a semiarid belt in which rainfall is slight and there are no pronounced wet and dry seasons. As we hoped to find, several species bred throughout the year. We studied 10 species especially and 8 of these showed some individuals in breeding condition at all times. However among these 8 we discovered certain other individuals that were in a full resting state. Thus they would have testes only 2 mm. long, as small as winter birds of the northern hemisphere, instead of 8 or 10 mm. long. Moreover the microscopic sections of the testes showed the resting stage was complete and revealed the profound changes from this condition to full breeding activity. This was especially well seen in *Tyrannus melancholicus*.

What we do not know in species like this is how long each year any one bird is in resting state and how long it is in breeding condition. Perhaps it rests twice in a year? To study this especially is the purpose of my work now on *Zonotrichia capensis*. This species was chosen particulary because other species of *Zonotrichia* in North America have been well studied and subjected to much experimentation in Berkeley.

At latitude 50º N, the northern *Zonotrichias* have the following cycle: 2½ months of full breeding capacity and 6½ months of resting state, the remainder of the 12- months year being periods of change. By experimental lighting we can change this to some extent within the limits of the required rest or refractory period. Thus the breeding and rest periods can be shortened and the birds show a physiological ability to have an 8-months total cycle or even a 6-month cycle instead of the normal 12 months. Does the equatorial *capensis*, then, show individual 12-, 8-, or even 6-month cycles? This species ranges from Chiapas, México, south to the cape region of South America, chiefly in the mountains, but of course we are concerned especially with the race at the equator. Populations of this species in Central America or in Chile may have very definite seasons that correspond to day length.

The only way to attack these questions seemed to be to follow the history of individuals, preferably in the wild in their equatorial environment. To do this, I am stationed for the year near Mares on the summit of the western Andes on Carretera al Mar west of Cali. I should like to state at this time my thanks to the Universidad del Valle for assistance and especially my very great appreciation to Profesor F. Carlos Lehmann V. for the great help he has given me in many ways in establishing near Mares, in bringing in and assembling equipment, and in providing sound technical advice and encouragement.

Our methods and such early results as we have obtained in our work since arriving on February 8 may be described. First, we trap *Zonotrichias* alive to place colored marking bands on their legs. Each also receives a numbered aluminium band for permanent record in the files of the United States Fish and Wildlife Service. By using two colors on each bird and placing them in various combinations on their two legs, we can give a distinctive mark to each one and know which bird it is when we see it later when it is singing, nesting, or feeding young. By now we have marked 120 individuals in an are of about 2 hectares.

Second, we can usually tell the sex of the bird externally by the length of the wing and the condition of the cloaca in adults. The males and females are colored alike but the males are larger and this shows in the wing. Also males that are breeding or which have recently bred have an enlarged cloacal gland which makes a lump at the cloacal opening that is 5 to 7 mm. high.

Third, if the bird is young, that is less than two months old, it has distinctive juvenal streaked feathers. But after these are molted we can perform a simple operation to determine its age up to about 5 months. This is done by cutting the skin over the skull, making an incision only 2 or 3 mm. long. The skin is thin and bleeds very little. The exposed skull is examined to see if the adult, double-layered bone type is present or the single-layered juvenal type. The cut is then closed and the edges held together with a small bit of adhesive scotch tape; the cut heals nicely in a few days.

Fourth, we may operate on the bird to examine the size and condition of the internal gonads —a laparotomy. This is done by anesthetizing the bird with Nembutal (2/100 cc. solution of Nembutal Sodium at 60 mg. (1 gr.) por cc.). The bird is strapped down and the feathers parted over the bare area above the posterior ribs. A cut is made about 7 mm. long through the skin and between the ribs just in front of the leg. The ribs are parted, mesentaries pushed aside, and the testes or ovary are exposed near the mid-line on the ventral surface of the kidneys. The testis is measured with fine calipers, or the same is done for the largest ovum in the ovary, and the bird is sewed up, merely by sewing the skin together. The membranes and muscles between the ribs will grow together under the skin and the thread in the skin falls off in a about two weeks. The bird is fully alert and active an hour later and can be turned loose in the wild, where, if it is a breeding male, it will at once reasume its singing. The surprising thing is that these and other birds are very resistant to infection. Instruments and thread are not sterilized. Yet with hundreds of such operations, I have never lost a bird from infection. We have now performed 30 laparotomies at our field station near Mares; some birds have had a second operation a month or more later and a few have had three operations. There has been only one casualty as a result of an overdose of anesthetic.

Fifth, we shoot samples from distant fields, several kilometers away, to preserve tissues for microscopic section of the various stages of breeding development and representing the several seasons. We are preserving these at once in the field and save testes, ovaries, adrenals, and thyroids. Thirty-six sample birds have been taken in this way up until now. Their skins and skulls are also saved to correlate their condition with the microscopic sections later.

Of the 120 live birds we have trapped, examined, marked and released, we have seen most of them again or have retrapped them. Only about 20 have not been seen later and these probably have moved a kilometer or so away where we are not watching; most were juveniles that have thus left. Some birds near the house we have seen every day when we have been home since February 10 and one bird has set a record by being recaptured in traps 54 times from Feb. 19 to June 29. Of course each bird is looked at carefully when it is recaptured for signs of breeding; the females for example develop a bare, vascular belly when they are incubating or brooding small young and males show larger or smaller cloacal glands in partial correlation with the size of the testes. We have proved now that a bird with much enlarged glands invariably has a large testis also. The reverse is not necessarily true. Also we watch the orderly progress of molt and the amount of yellow fat which one can be seen through the skin.

All of this evidence and the behavior of the birds which we watch gives us a good picture of what goes on in their lives. Already some conclusions may be stated which will probably have even more supporting evidence later.

First, we know that young males five months of age become fully developed sexually and that females actually nest at this age. This is determined by finding how long the young take to grow, molt to adult plumage, and acquire a nearly adult skull. We have examined breeding birds whose skulls are not yet quite adult.

Second, we know that some males at least can go through the entire process of rest and regain full testis size with a period of only 2 months, the rest time itself being only about one month. This is shown by histories of marked males which were nesting in February and, as laparotomies have shown, have since reduced the testes and then regrown them again. Therefore the total cycle may be shorter than we supposed; we had thought that four months might be necessary for this change. Probably the high plateau of breeding condition is longer than we had postulated, but we will not know that until later in the year. Already we are sure that some males stay in breeding condition for as much as four months at a time.

I now think that some *Zonotrichias* are in breeding state at all times of the year but a majority of our birds rested for a short time in March. This may happen again in August or September in this population. If we are fortunate and our marked birds survive and continue to live about our station, we hope to have this and many more questions answered by next January.

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SUMARIO

Para el estudio de los ciclos reproductivos de las aves cerca al ecuador se seleccionó el Gorrión (*Zonotrichia capensis*) teniendo en cuenta que se han realizado estudios intensivos en especies próximas que habitan el hemisferio norte.

Se escogió como estación de trabajo, el sitio denominado Mares, localizado en la cima de la Cordillera Occidental sobre la carretera que conduce de Cali a Buenaventura.

Mediante trabajos de anillado, instalación de trampas para captura de las aves, realización de laparotomías y observación constante, se ha llegado a las siguientes conclusiones preliminares:

a) Que las aves cerca del ecuador tienen como en otras latitudes períodos o ciclos de reproducción, aunque la especie en conjunto pueda estar anidando prácticamente durante todo el año.

b) Que los machos están en condiciones fisiológicas para reproducirse a los cinco meses de edad y que con seguridad algunos permanecen en condiciones de reproducción durante cuatro meses contínuos; además que las hembras anidan a los cinco meses de edad.

c) Que estas aves tienen una marcada resistencia contra las infecciones que podrían sobrevenirles por el empleo de instrumental quirúrgico sin previa desinfección, usado en las intervenciones. Algunos individuos fueron operados hasta tres veces y tan solo se sabe de uno que murió, no debido a infección sino a una alta dosis de anestesia.

A partir del ocho de febrero del presente año, se han anillado ciento veinte (120) individuos en un área aproximada de dos hectáreas, y se ha coleccionado material adicional en la vecindad de la estación de estudio, el cual se preserva para futuros estudios comparativos.